Inline Exhaust Device to Improve Efficiency of a Catalytic Converter

Field of the Invention.

This invention is directed to a device that can sit within, or be associated with an exhaust stream of an internal combustion vehicle and which can improve the efficiency of the catalytic converter in the exhaust stream, typically by keeping parts of the catalyst hotter than otherwise would be possible.

Background Art.

Internal combustion engines such as gasoline or petrol engines provide toxic emissions which contain carbon monoxide, nitrogen oxides and the like.

One way by which these toxic emissions can be reduced is to provide a catalytic converter in the exhaust stream. A common catalytic converter is a three-way converter that reduces the three regulated emissions - carbon monoxide, VOC's, and nitrogen oxides. The catalytic converter typically uses two different types of catalysts, being a reduction catalyst and an oxidation catalyst. The converter usually comprises a honeycomb of ceramic or metal structure which is coated with a metal catalyst which is typically platinum, palladium or rhodium.

One of the biggest shortcomings of the catalytic converters is that they only work efficiently at fairly high temperature. One simple way to keep the catalytic converter hot is to make sure that the converter is positioned upstream in the exhaust system and close to the engine. However, this is not always convenient and can result in the catalytic converter becoming too hot which will cause damage to the catalytic converter.

Thus, it is also known to preheat the catalytic converter. This is commonly done using an electric preheating element which is powered by the vehicle battery and which heats the catalytic converter to the operating temperature. During normal operation of the engine, the heat of the exhaust gases is usually sufficient to keep the

catalytic converter at its operating temperature, and the preheating element can then be switched off. However, an electric preheater still requires several minutes of operation to heat the catalyst to the operating temperature. Also, the preheater can create a considerable power drain to the battery, and will not be suitable for engines that do not have a battery (such as lawnmower engines).

Another major operational problem with inline catalytic converters is that the converter temperature can drop below an operating level when the engine is idling. For instance, if the vehicle is in heavy traffic, or is stopped by a red traffic light, the engine revolutions decrease to idling speed. This causes the temperature of the exhaust gases to quickly drop to a level where the temperature does not properly maintain the catalytic converter in its operational temperature zone.

Therefore, there would be an advantage if it were possible to provide some means which can maintain the catalytic converter in its operational temperature zone for a longer period of time than would otherwise be possible especially if the engine speed reduces (for instance is idling).

It will be clearly understood that, if a prior art publication is referred to herein, this reference does not constitute an admission that the publication forms part of the common general knowledge in the art in Australia or in any other country.

Object of the Invention:

It is an object of the invention to provide an inline exhaust device that can improve the working of a catalytic converter and which may overcome at least some of the above-mentioned disadvantages or provide a useful or commercial choice.

In a broad form, the invention comprises a device to improve the working of an inline catalytic converter, the device affecting the flow of hot exhaust gasses to improve the transfer of heat from the exhaust gasses to the catalytic converter.

In this manner, there is less, or no need for a separate electric heater for the catalyst. This now enables smaller engines [lawnmower engines etc] to have a catalytic converter which works more efficiently, as these engines do not usually have a battery to enable an electric heater to heat the catalyst.

In a more particular form the device comprises a particular internal profile which contacts the exhaust gasses and absorbs heat from the exhaust gasses. The profile may comprise or include a plurality of recesses or cavities to facilitate increased turbulence of the gasses which may improve the heat absorption.

In another form, the invention resides in a device to improve the working of an inline catalytic converter, the device comprising a plurality of cavities or spaced apart members that extend at least partially into the exhaust stream, and adjacent the catalytic converter, the cavities or spaced apart members functioning to absorb heat from the exhaust stream and to keep at least part of the catalytic converter at an elevated temperature.

In this manner, the device can absorb heat from the hot exhaust gases when the engine is running normally and should the engine idle, and the exhaust gas temperature drop, the device can radiate or otherwise transmit heat to part of the catalytic converter, or warm part of the catalytic converter to maintain the converter at least partially in its more efficient operating temperature during the idling time. Of course, the device cannot indefinitely maintain the temperature of the catalytic converter, but it should be effective during stop/start traffic or ordinary periods of idling.

The device will typically be placed downstream from the catalyst. It may also be possible to place the device in front of the catalyst, but in some exhaust systems, the front portion can get quite hot and it may not be efficient to place the device in front of the catalyst. However, if the exhaust system is such that the catalyst is far enough away from the engine, it may be possible to place the device in front (upstream) of the catalyst as well as, or instead of, behind the catalyst.

The device is preferably configured to absorb heat from the exhaust stream but without unnecessarily creating a backpressure in the exhaust. A backpressure is not always advantageous as too much backpressure can reduce the engine power by between 20%-30% and can increase fuel consumption.

For this reason, it is preferred that the device comprises a plurality of spaced apart members that extend at least partially into the exhaust stream, at least some of the members being provided with an opening extending therethrough through which at least some of the exhaust gases can pass. It is preferred that the members extend substantially about the inner wall of the exhaust. Therefore, if the exhaust is substantially circular, it is preferred that the members comprise circular disks containing a central opening through which exhaust gases can pass. Of course, if the exhaust has a square, oval or rectangular cross-section, the shape of the members can vary to accommodate these configurations.

The number of spaced apart members may vary depending on the size of the exhaust, the volume of exhaust gases, etc. Typically, the device will contain between 2-20 spaced apart members and preferably between 4-10 spaced apart members.

The device may comprise a sleeve to which the spaced apart members are attached. The sleeve may be designed to slide within the exhaust system to a position adjacent the catalyst. Alternatively, the sleeve may be designed to be part of the exhaust system and clamped to the exhaust or otherwise attached to the exhaust pipe. The sleeve may alternatively have another internal profile to improve heat transfer from the gasses to the device.

The spaced apart members (or other profile) may be spaced apart by a distance of between 3-50 millimetres and typically between 5-20 millimetres. A function of the spaced apart members is to create turbulence in the exhaust gas to cause part of the exhaust gas to swirl or be turbulent about and between the spaced apart members. It is considered that this improves the absorption of heat from the exhaust gases and into the spaced apart members. This can be due to increased resident time between the hot exhaust gas and the member caused by the turbulence or "eddy" effect which may

function to cause the cooler gasses on the "outside" of the gas stream and which are in a heat exchange relationship with the device to be replaced by the hotter gasses in the "central" part of the gas flow, thereby causing the catalytic converter to heat up more quickly. This effect need not substantially increase the resident time of the gasses in the exhaust.

The spaced apart members will preferably be formed from materials which will be strong enough to survive in the hot exhaust gases while still being relatively efficient in absorbing heat from the gases. Metals such as steel are considered suitable. However, no limitation should be placed on the invention merely by providing steel as a suitable material from which the spaced apart members can be made. The members can be made from other suitable metals, metal alloys, sintered metals, nonmetallic heat absorbing members, composite materials and the like.

The spaced apart members will typically extend from the edge of the exhaust tube into the gas flow sufficiently to efficiently absorb heat from the gas flow without unnecessarily impeding the gas flow to create an undesirable backpressure. It is considered that the spaced apart members may extend into the exhaust tube by a distance of between 10%-80% of the area. In one embodiment, this can be achieved by having the spaced apart members comprising substantially circular disks having an opening extending therethrough with the area of the disk comprising between 10%-80% of the cross-section area of the exhaust tube.

One function of the spaced apart members is to create eddies or turbulence in at least part of the gas flow *inter alia* to improve the ability of the members to absorb heat from the gas flow. For this reason, the profile of the members may be such to improve this effect. In one form, the spaced apart members may be substantially disk-like having parallel sidewalls. However, in another form the, or each, side wall may be profiled to improve turbulence. The profile may comprise a recess or "concavity" in the or each side wall. In another form, the members may comprise a ramped surface which may extend towards or away from the catalytic converter. Other profiles and configurations are envisaged to improve the turbulence of the gas flow.

It is considered beneficial to have a spacing gap between the catalytic converter and the first member of the device. While not wishing to be bound by theory, we believe that this gap improves the ability of the heat absorbed by the device to radiate the heat (or otherwise transmit the heat) back to the catalytic converter. The gap can comprise a "heat curtain" and can be anywhere between 5 millimetres-100 millimetres and preferably about 25 millimetres.

In another more particular form of the invention, the device may comprise a valve or iris which is operable between an open position and a closed or partially closed position, the valve being downstream from the catalytic converter and functioning to increase the resident time of the exhaust gas about the catalytic converter especially when the engine is idling.

Thus, when the engine is idling, the valve may be in a closed or partially closed position to keep the hot exhaust gases in the exhaust stream and about the catalytic converter to keep the temperature of the catalytic converter higher than would otherwise be the case if the exhaust gases were simply allowed to pass through the exhaust system unencumbered.

The method may comprise a single valve as described above or a plurality of valves. If a plurality of valves is provided, these may be in "series" in "parallel" or in any combination thereof. The valve(s) may include an iris(s)

The valve may be provided downstream of the catalytic converter to throttle or choke the exhaust gases when necessary to ensure that the catalytic converter is kept at a higher temperature than would otherwise be possible. It is envisaged that the valve can be positioned at any position downstream of the catalytic converter including immediately behind the catalytic converter, or some distance away from the catalytic converter, or even external of the exhaust pipe.

It is envisaged that no particular limitation should be placed on the type of valve that may be used. Therefore, the valve may comprise a simple hinged flap valve, a slide valve, a rotating valve, a gate valve, an iris and the like.

It is preferred that the valve is operated such that it will move to a more open position or a fully open position upon an increase of the volume of exhaust gases passing through the exhaust system. For instance, it is preferred that the valve moves to a more open position when the engine revs at higher resolutions as sufficient hot gases now pass over the catalytic converter. It is preferred that the valve is operable in an automated or semi-automated manner. In a very simple form, the valve may comprise a hinged weighted valve, which moves under the influence of gravity to a closed position when the engine gas volume is low but which is pushed by the engine gas volume to an open position when the gas volume is higher. Alternatively, the valve may be spring biased to a naturally closed position and can be pushed to the open position by the volume of the engine gas. Alternatively, the valve may be operated by temperature and may move from a closed position to an open position upon an increase in the temperature. This type of valve may be called a "thermostat valve". Alternatively, the valve may be operated by pressure differential in the exhaust stream. Other types of operating means to operate the valve may be used.

Brief Description of the Drawings.

Embodiments of the invention will be described with reference to the following drawings in which:

Figure 1 illustrates a device positioned downstream from a catalytic converter.

Figure 2 illustrates a different profile of the spaced apart members in the device.

Figure 3 illustrates yet another profile of the spaced apart members in the device.

Figure 4 illustrates a typical exhaust system.

Figure 5 illustrates an exhaust system and illustrating various places where "secondary air" can be inserted into the exhaust stream.

Figures 6-10 illustrate various embodiments of a valve used to improve the working of an inline catalyst.

Best Mode.

Referring initially to figure 4, there is illustrated a typical exhaust system that extends from the engine 10 to the tailpipe 11 and which contains an inline muffler 12, a

catalytic converter 13, and a device 14 according to a first embodiment of the invention and which is mounted behind (downstream) the catalytic converter 13.

Referring to figure 1, there is illustrated a device according to an embodiment of the invention. The device 14 is positioned downstream from catalytic converter 13. Hot exhaust gases from the engine pass into the front of catalytic converter 13 at a temperature of between 200°-270° centigrade (this can of course vary). At the rear end of the catalyst is a small air gap 15 having a length of about 25 millimetres. The device 14 comprises five spaced apart members 16, each member comprising a circular disk having a central aperture 17 through which the exhaust gases can pass. The central aperture 17 of each disk is aligned with the central aperture of each other disk to provide a central flow pathway 18 which is substantially unimpeded.

The disks are spaced apart by about 20 millimetres. As exhaust gas flows from catalyst 13 and through the aligned central apertures 17 of each disk, eddies and turbulence is provided about each disk causing exhaust gas to flow into the spacing between adjacent disks. This hot exhaust gas can then exchange heat with the respective disks causing the disks to heat up. This continues along the length of the device until the exhaust passes through the device and towards muffler 12.

Figures 2-3 illustrate different designs of the spaced apart members 16. The designs are to improve the edge effects between the gas and the member to cause turbulence and eddies to be formed between the spaced apart members.

The design does not increase the backpressure of the exhaust to an undesirable degree which can cause a reduction in engine power and increase in fuel consumption. It is considered that the aligned apertures in the disks enable exhaust gas to still flow through the device, and it is considered that having the spaced apart members provides a better heat exchange.

Tests have shown that under engine idling conditions, the temperature at the front of the catalyst is about 150° and, without the device fitted, the temperature at the rear of the catalyst is about 100°. When the device is fitted, this increases the temperature at

the rear of the catalyst to about 200°.

Referring to figure 5, there is illustrated an exhaust system similar to that of figure 4, except that figure 5 illustrates various positions 20-22 where secondary air can enter into the exhaust system. For instance, at position 20, secondary air can enter the exhaust system after engine 12 but before the catalytic converter 13. At position 21, secondary air can enter into the exhaust system after the catalytic converter 13 but before muffler 12. At position 22, secondary air can enter into the exhaust system in muffler 12. At position 20, the secondary air can provide additional oxygen for assistance in proper catalytic conversion of the exhaust gases. At position 21 and position 22, the secondary air dilutes the exhaust gases to reduce the percentage of the emissions from the tailpipe.

Referring to figures 6-10, there is illustrated another embodiment of the invention where the device is a valve that can be of various configurations and types, and can be placed in various positions in the exhaust stream. The valve functions to throttle the engine gases to "bathe" the catalytic converter 13 in the hot engine gases for longer than would be possible without the valve.

Figure 6-7 show a simple hinged valve 23 which can be positioned on the end of tailpipe 11. The valve is naturally weighted to the closed position (figure 6) and is pushed to the partially open position (figure 7) by the force of exhaust gases passing through the tailpipe. Thus, on the idling conditions, the valve will be mainly closed and this will result in the exhaust gases slowing down especially about the catalytic converter 13 such that the catalytic converter can stay hotter.

Figure 8 illustrates a simple hinged valve 24 which is positioned inside part of the exhaust system and again can move between a naturally closed position and a partially opened position (shown in phantom line), again by the force of exhaust gases.

Figure 9 illustrates a valve 25 that can be pushed downwardly by the force of the exhaust gases and move between a naturally closed position by virtue of spring 26 and a pushed down open position illustrated in figure 9.

Figure 10 illustrates a turn valve 27 which can be rotated about a pivot axis 28, between an open position illustrated in figure 10 and a closed position where the valve has been rotated by 90° to block off the flow of gases. The turn valve 27 can be operated by heat which means that as the valve heats up, it moves to the open position. The valve can be heated by the exhaust gases. Alternatively, another type of thermal reed valve , or flap or disk can be used.

The valve will typically be positioned downstream from the catalytic converter to provide a degree of throttling or backpressure under low engine idling conditions to keep the hot exhaust gases about the catalytic converter for longer than would be otherwise possible if the valve was not in place.

It is envisaged that the invention will extend to a combination of a device 14 typically as illustrated in figures 1-4 and a valve typically as illustrated in figures 6-10.

The secondary air injection (see for instance figure 5) can be carried out with the valves in place or with the device 14 in place or both.

Tests carried out on the temperature on the rear of the catalytic converter using the device as illustrated in figures 1-4 show a marked increase of the temperature on the rear of the catalytic converter.

In an experiment, and using an engine containing the device illustrated in figures 1-4, the front of the catalytic converter was between 34°-70° over a five-minute period, and the rear of the catalytic converter was between 70°-140°. With the same engine under a 500 watt load condition, the front of the catalytic converter was between 46-180° over a five minute period while the rear of the catalytic converter was between 131-324°. The results show that the rear of the catalytic converter is kept quite warm due to the device re-radiating heat back to the catalytic converter.

The warming of the catalytic converter had an advantageous reduction on the emissions. In an experiment, a HONDA NSR 150cc two-stroke engine was used to test the reduction in emissions using the device is illustrated in figures 1-4.

Without the device fitted, the emissions were as follows:

Lda	0.872ULP
RPM	4384
O2	3.32%
NO	14 ppm
CO2	9.14%
HC [hydrocarbons]	4902 ppm
CO	2.848%

With the device fitted, the emissions over several hours were as follows:

TIME [Hr]	Lda	RPM	O2%	NO ppm	CO2%	HC ppm	CO%
1	0.902	4559	0.00	2	13.37	1093	2.103
4	0.907	4657	0.32	2	13.51	1505	1.92
5	0.889	4455	0.00	2	13.28	1533	2.0
7	0.895	4311	0.23	3	13.46	1744	2.0
9	0.896	4421	0.49	3	13.27	1787	2.29
12	0.879	4717	0.00	3	13.17	1695	2.23

Thus the device functions to reduce emissions, primarily NO and hydrocarbons from an exhaust stream.

Throughout the specification and the claims (if present), unless the context requires otherwise, the term "comprise", or variations such as "comprises" or "comprising", will be understood to apply the inclusion of the stated integer or group of integers but not the exclusion of any other integer or group of integers.

Throughout the specification and claims (if present), unless the context requires otherwise, the term "substantially" or "about" will be understood to not be limited to

the value for the range qualified by the terms.

It should be appreciated that various other changes and modifications can be made to any embodiment described without departing from the spirit and scope of the invention.